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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14 JAN 2005

| Applicant's or agent's file reference<br>TS 6375 PCT | **FOR FURTHER ACTION** | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |
|---|---|---|
| International application No.<br>PCT/EP 03/07787 | International filing date *(day/month/year)*<br>17.07.2003 | Priority date *(day/month/year)*<br>17.07.2002 |
| International Patent Classification (IPC) or both national classification and IPC<br>B23K33/00 | | |
| Applicant<br>SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V. | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

| Date of submission of the demand | Date of completion of this report |
|---|---|
| 17.02.2004 | 15.10.2004 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office - P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk - Pays Bas<br>Tel. +31 70 340 - 2040 Tx: 31 651 epo nl<br>Fax: +31 70 340 - 3016 | Authorized Officer<br>Jaeger, H<br>Telephone No. +31 70 340-4571 |

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP 03/07787

## I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

**Description, Pages**

| | |
|---|---|
| 1, 3-8 | as originally filed |
| 2, 2a | filed with telefax on 27.08.2004 |

**Claims, Numbers**

| | |
|---|---|
| 1-13 | filed with telefax on 27.08.2004 |

**Drawings, Sheets**

| | |
|---|---|
| 1/2-2/2 | as originally filed |

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   *(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 2, 3, 5-13 |
| | No: | Claims | 1, 4 |
| Inventive step (IS) | Yes: | Claims | |
| | No: | Claims | 1-13 |
| Industrial applicability (IA) | Yes: | Claims | 1-13 |
| | No: | Claims | |

2. Citations and explanations

   **see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

V.1 The following documents (D) are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

D1: JP 03-243286 A
D2: US 4 669 650 A
D3: GB 793 402 A

V.2 Novelty

Claim 1: Document D2 discloses a method for interconnecting tubulars (1, 2) by forge welding, the method comprising shaping at least one of the inner and outer walls of the tubular ends that are to be welded together into an inwardly sloping configuration such that when the tubular ends are heated during the forge welding process the heated tubular ends deform as a result of thermal expansion into a substantially longitudinally oriented cylindrical shape (see column 3, lines 28 and 29) and that the sloping angle of the inner and outer walls of the tubular ends is selected such that the ratio between the average diameter D(t) of the tip of the tubular end and the average diameter D(b) of the base of the tubular end is related to an estimated temperature difference between said tip and base of the tubular end during the forge welding process and a thermal expansion co-efficient of the steel grade or grades of the tubular end.

The features relating to the ratio between D(t) and D(b) are implicitly disclosed by D2 (see column 3, lines 24-25: "[...] to more easily obtain a tri-axial stress condition when the material [...] flows [to] obtain the form" for the following reasons: The desired form in D2 is cylindrical as in the application. The stress condition during joining depends on material properties like thermal expansion co-efficient and steel grade and on process parameters of the forge welding method like pressing force and preheat temperature of the pipe ends, the latter resulting in a temperature difference of the tip of the tubular ends and the base of the tubular ends. Since according to D2 the pipe ends are shaped inwardly sloping and reduced in cross section in order to obtain a cylindrical shape, it is inherent that the reduction in cross section, which corresponds to the claimed sloping angle and

the resulting ratio between D(t) and D(b), is selected according to the material and process properties. Therefor D2 discloses all the features of claim 1. D1 also discloses all the features of claim 1.

Claim 4: D2 also discloses pipe ends with a reduced wall thickness.

V.3 Inventive Step

Claim 2: The subject-matter of this claim consists in the selection of a range from not further specified ranges described e.g. in document D2. Such a selection can only be regarded as inventive, if this range presents unexpected effects or properties in relation to the rest of the range. However, no such effects or properties are indicated in the application. Hence no inventive step is present in the subject-matter of claim 3.

Claim 3: D3 discloses pipes with concave and convex ends for the same purpose as laid out in the application. It would therefore be obvious for the person skilled in the art to apply these features to the tubular ends of D2.

Claims 5 and 6: D1 discloses the forge welding of clad steel pipes. It would be obvious to the person skilled in the art to include the concave / convex ends disclosed in D3 in forge welding method of D1 and thus arriving at method of forge welding according to claim 5 without involving an inventive step. D1 further discloses wedge shaped ends with the tips being formed by the cladding.

Claim 7: The term "only the adjacent end portions" seems to contradict the fact that clad pipes are to be welded. However, if the cladding is only in the joining portion, it can be seen as a weld enabling layer, the use of which is state of the art.

Claims 8-12: These claims relate to the use of flushing or reducing gas. The features of claims 1+3+5+8-12 are a juxtaposition of features solving non-related problems the solutions of which are known in the prior art (cl. 8 - flushing/inert/ reducing gas: remove oxides, protect weld from oxidation (see D2); claim 6 - clad part of pipes touch first during welding: cladding while maintain the thickness through the joint (see above); claim 4 - concave/convex end faces: facilitate centering; claim 1 - bevelled pipe ends: reduce burr resulting from forge welding (see above). Therefore these claims do not involve an inventive step.

Claim 13: It is obvious to the person skilled in the art to use the tubes disclosed by D2 as oilfield tubulars.

(47)

substantially insert gas, such as argon, nitrogen and/or helium, and about 5% by volume of a reducing gas, such as hydrogen and/or carbon monoxide for flash welding and induction butt welding.

Experiments have shown that forge welding techniques are capable to generate high quality metallurgical bonds between tubular ends, in particular if the pipe ends are flushed with a reducing flush gas mixture during the heating and/or welding operation, but that the red-hot pipe ends are generally deformed such that upsets are formed in the region of the welding zone.

For many applications it is required to remove upsets after the welding operation, which then involves a grinding or machining operation which is difficult and expensive to accomplish at many sites where pipe ends are welded together, such as on oil rigs, pipe-laying barges and many offshore and onshore sites where underground or above ground pipelines are to be installed.

The method according to the preamble of claim 1 is known from US patent 4,669,650. In the known method the tubular ends are shaped in an inwardly sloping configuration. Japanese patent JP 03-243286 also discloses a forge welding method wherein the tubular ends have an inwardly sloping configuration. UK patent GB 793402 discloses a forge welding method wherein the welded pipe ends have complementary concave and convex shapes.

It is an object of the present invention to provide a method for forge welding of tubulars wherein the generation of upsets in the welding zone is minimized.

Summary of the Invention

The method according to the inventions comprises shaping the tubular ends that are to be welded together

into a sloping configuration such that when the tubular ends are heated during the forge welding process the heated tubular ends deform as a result of thermal expansion into a substantially longitudinally oriented cylindrical shape, wherein the sloping angle of the inner and outer walls of the tubular ends is selected such that the ratio between the average diameter D(t) of the tip of the tubular end and the average diameter D(b) of the base of the tubular end is related to an estimated temperature difference between said tip and base of the tubular end during the forge welding process and a thermal expansion co-efficient of the steel grade or grades of the tubular end.

In addition the portion of each pipe that is to be forged may be reduced in cross section such that deformation during forging returns it to a dimension substantially the same as its original thickness.

C L A I M S

1. A method for interconnecting tubulars by forge welding, the method comprising shaping the tubular ends that are to be welded together into an inwardly sloping configuration; characterized in that the sloping configuration is such that when the tubular ends are heated during the forge welding process the heated tubular ends deform as a result of thermal expansion into a substantially longitudinally oriented cylindrical shape, and that the sloping angle of the inner and outer walls of the tubular ends is selected such that the ratio between the average diameter D(t) of the tip of the tubular end and the average diameter D(b) of the base of the tubular end is related to an estimated temperature difference between said tip and base of the tubular end during the forge welding process and a thermal expansion co-efficient of the steel grade or grades of the tubular end.

2. The method of claim 1, wherein said ratio D(t)/D(b) is between 0.8 and 0.99.

3. The method of claim 1, wherein the end face of one of the tubular ends that are to be welded together has a substantially convex shape and the end face of the other tubular has a substantially concave shape.

4. The method of any preceding claim, wherein the tubular ends are machined to a reduced wall thickness in the welding zone.

5. The method of claim 3, wherein tubulars comprise a low grade steel base pipe and a higher grade steel cladding on the inner and/or outer surface of the base pipe and the end faces are shaped such that when the tubular ends are pressed together the end faces of the cladding(s) touch each other before the end faces of the base pipe ends touch each other.

6. The method of claim 5, wherein the tubular ends are wedge shaped and the tips of the wedges are formed by the claddings.

7. The method of any one of claims 1-4, wherein only the adjacent end portions of adjacent low grade steel base pipes are covered with clad metal to allow further machining of said end portions without exposing the base pipes.

8. The method of claim 5, wherein during at least part of the forge welding operation a flushing gas is flushed around the welding zone and at least part of the flushing gas is injected into the welding zone from the uncladded side of the tubular, such that the injected flushing gas can continue to reach the ends of the still spaced base pipes after the claddings have touched each other.

9. The method of claim 8, wherein the flushing gas is a reducing flushing gas.

10. The method of claim 9, wherein the flushing gas is a non-explosive mixture of a substantially inert gas and a reducing gas.

11. The method of claim 10, wherein the substantially inert gas comprises helium, argon, nitrogen, and/or carbon dioxide and the reducing gas comprises hydrogen and/or carbon monoxide.

12. The method of claim 11, wherein the non-explosive flushing gas mixture comprises more than 90% by volume of a substantially inert gas and at least 2% by volume of hydrogen.

13. The method of any preceding claim, wherein the tubulars are oilfield and/or well tubulars.